the microhabitats for several species of frogs.

During the short stay (28 October to 3 November 1990) I came across at least 10 of these torrent toads at an altitude of *c*. 600 m. There were more juveniles and these were often far from water in the wet litter. The adults were on wet rocks just above water in the fast flowing rivers. There were freshly metamorphosing toads with tails on the rocks above water and also tadpoles clinging to the rocks in the torrents of at least one of the rivers visited.

The Malabar torrent toad is quite remarkable for its slender build and striking colour. For possible benefits of camouflage, the most striking colour pattern of bright yellow and red are restricted to the underside of the toad. The adults noted were 2.8-3.2 cm in length (snout-vent), jet black above with yellow spots on the limbs and belly. The belly is brick red, the red being a circular patch. The number of yellow spots on this red belly is variable. I found adults with 1, 2, 3 and 5 spots on the belly. The juveniles lack the yellow spots but have a red belly patch, though less clearly defined. Dorsally they are more marbled with olive. The freshly metamorphosing toads are more olivaceous with fine black marbling. The tadpoles are black, stocky and comparatively short-tailed and show remarkable capacity to cling to the slimy rocks under water. One tadpole was observed scaling a rock to get to a small puddle of rain water.

I was not able to observe anything on the toad's food and behaviour in the field. One adult that is in a small terrarium at Bangalore prefers to sit on top of a rock provided, in an upright position, displaying the bright colours on the belly and limbs. It has not yet started accepting food.

November 16, 1990 RANJIT DANIELS

32. ON THE MIGRATION OF THE LARGE CABBAGE WHITE BUTTERFLY *PIERIS BRASSICAE* IN KASHMIR

(With a text-figure)

The large cabbage white *Pieris brassicae* is common in the western Himalayas. It is an altitudinal migrant, descending to plains and lower hills in winter and migrating back in summer (Wynter-Blyth 1957). The mass movements of this species are conspicuous and well documented in Europe (Williams 1930), but the published data from India is fragmentary. The following is one such instance of migration of this species.

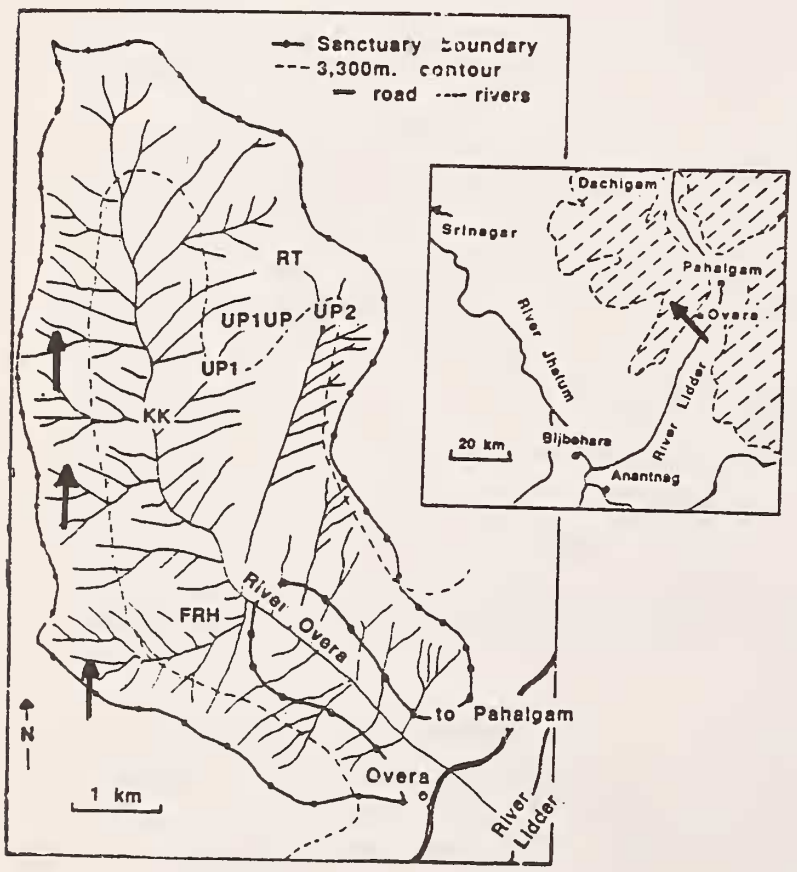

Fig. 1. Overa Wildlife Sanctuary. Dotted line is the approximate 3300 m contour. Arrow shows direction of butterfly migration.

The location was the western ridge of the Overa Wildlife Sanctuary, Kashmir, the altitude being 3800 m. On one side the ridge falls sharply towards Liddar valley and on the other side the slope is gradual towards the Jhelum valley. The top of the ridge is narrow at some places broadening to grassy meadows strewn with alpine flowers. The ridge is flanked by stands of silver birch (*Betula* sp.), sparser near the top.

The mass movement of butterflies was first noted on the morning of 28 May 1988. The weather was calm, clear and sunny, and remained thus throughout. It continued till afternoon of the next day. Thereafter it became cloudy, overcast with a hint of rain. As we became aware of the sudden influx of butterflies it became apparent that a migration was in progress. The butterflies were coming up the ridge in an incessant stream. The flight was rapid in one direction and the butterflies were flying on, hardly resting. They kept mostly to the crest of the ridge, and at the centre the air appeared to be thick with butterflies, flying from ground level almost till the eye could reach. So striking and conspicuous was this movement that it was impossible not to notice it. The direction of the flight was from south to north (Fig. 1).

The flight of the butterflies was followed uptil a point where the ridge rises sharply to about 4000 m. Here the butterflies were fluttering up close to the cliff face in

a scrambling flight and disappearing over the top. The flow continued in profusion till afternoon of the next day, then became sparse and irregular. To estimate the total number of butterflies, the number passing through an area 30 m high and 30 m in width were counted at 1140 hrs on 28 May, by using a chronometer. In two minutes, 102 butterflies passed through the segment. The butterflies passing outside this segment were not counted. By a crude estimate, considering that a very negligible portion was flying through the segment, at least 75,000 to 80,000 butterflies passed the camp site in the day and a half. Despite such abundance of cabbage white butterflies and presence of black swift *Apus apus*, hobby *Falco subbuteo*, kestrel *Falco tinnunculus*, predation was not noticed. This butterfly is considered as distasteful.

There are a few reports on migration of *Pieris brassicae*. Hingston (vide Williams 1930) has described the on (*Hydrilla* sp.) was kept in the aquarium to provide substratum for the waterbugs. The snail *Lymnaea luteola* of different size classes were supplied to the bugs as food regularly. The female waterbugs deposited eggs on the back of the males within a few days. Four such egg-bearing males were kept separately, in a plastic container of two litre capacity, at 20°C, 25°C, 30°C, constant temperature grades maintained in different chambers of a BOD incubator and at room temperature (19°C-35°C). The newly hatched nymphs were maintained carefully with the supply of preferred sized *L. luteola* daily, as their food. The experiments were terminated when all the waterbugs (nymphs) metamorphosed into adults. Throughout the experi

Another summer season (May-June 1989) was spent in the same area, but the migration was not noticed. Specimens of *P. brassicae* were collected and added to the BNHS collection. The identification was confirmed by Mr. Naresh Chaturvedi. Thanks are also due to him for help with references.

Similar other records of migration of this species will be worth placing on record so as to eventually plot a definite route/pattern of migration.

October 12, 1989 NITIN JAMDAR

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33. INFLUENCE OF TEMPERATURE ON SEX DETERMINATION OF THE WATERBUG *SPHAERODEMA RUSTICUM* FAB.

Though sex determination is a purely genetic mechanism, the influence of environmental factors on the same cannot be ruled out (Conover and Heins 1987, Conover and Kynard 1981, Charnov and ull 1977). Of the environmental factors, temperature seems to be the most important one. It is reported that the sex ratio in a few invertebrates, fishes, alligators and turtles varied widely in response to temperature regime (Conover and Heins 1987, Conover and Kynard 1981, Bull and Vogt 1979, Charnov and Bull 1977). Investigation on this aspect in insects is necessary. We have studied it in the waterbug *Sphaerodema rusticum* Fab. and the results are given below.

A good number of adult waterbugs *S. rusticum* were collected from a pond located in the Ballygunge Science College campus, Calcutta University, Calcutta, and kept in an aquarium measuring 60 x 25 x 45 cm, filled with pond water up to 30 cm height. A considerable amount of aquatic vegetation (*Hydrilla* sp.) was kept in the aquarium to provide substratum for the waterbugs. The snail *Lymnaea luteola* of different size classes were supplied to the bugs as food regularly. The female waterbugs deposited eggs on the back of the males within a few days. Four such egg-bearing males were kept separately, in a plastic container of two litre capacity, at 20°C, 25°C, 30°C, constant temperature grades maintained in different chambers of a BOD incubator and at room temperature (19°C-35°C). The newly hatched nymphs were maintained carefully with the supply of preferred sized *L. luteola* daily, as their food. The experiments were terminated when all the waterbugs (nymphs) metamorphosed into adults. Throughout the experiment strict hygienic conditions were maintained by changing the pond water, by removing the dead snails and waterbugs, if any, by removing the empty shells of *L. luteola* and by changing the plant materials regularly.

The number of newly hatched nymphs, the number of adult waterbugs metamorphosed out of these nymphs, the number of male and female waterbugs in respect of the selected 4 clutches against four different temperature grades have been shown in Table 1. It is evident that the sex ratio at 30°C constant temperature was 1 : 1 (M:F) while at 25°C and 20°C the same was 1 : 2 and 1 : 5.5 respectively.